ing the coordinating control in blank referenced by numeral **10** having as schematically shown suitable connecting means **12, 14, 16** connecting the actuator **18** for the variable exhaust nozzle **20** of bypass duct **22;** connecting the pitch change mechanism of the variable pitch fan generally illustrated by numeral **24;** and connecting the fuel control **26,** respectively.

Fuel control **26** may be any well know commercially available fuel control, such as the JFC-42-2 or the JFC-26 model manufactured by the Hamilton Standard Division of United Aircraft Corporation or the type illustrated in U.S. Pat. No. 2,822,666 granted to S. G. Best on Feb. 11, 1958 and also assigned to the same assignee suitably modified to complement this invention. Suffice it to say that the fuel control serves to meter fuel to the engine as a function of the control logic and serves to prevent surge, overtemperature and overpressurization in a well known manner. However, the control, according to the teachings of this invention, would of necessity be suitably modified to reflect the utilization of the parameters monitored by and converted into control logic by the control **10.** This aspect of the invention will be more fully appreciated from the description to follow, but one skilled in this art would have no difficulty in applying the teachings of this invention to the established fuel control technology.

In the instance, the fuel control **26,** receiving the control logic from the coordinated control **10** serves to meter the proper amount of pressurized fuel received from pump **28** to the burner section of the gas turbine engine via line **30.** Preferably fuel control **26** will provide protection for the gas generator so as to prevent overtemperature, overtorque, overspeed and overpressure conditions, as well as avoiding surge and flame out as power is varied.

While not specifically limited thereto, as will be appreciated by one skilled in the art, the preferred embodiment contemplates a gas turbine engine having a free turbine, i.e., the free turbine is not mechanically connected to the gas generator and its sole connection is through the aerodynamic coupling of the gases which flow through the compressor and turbine sections.

The pitch change mechanism shown in blank by reference numeral **34** responding to the coordinated control **10** via connection **14,** may be any suitable type and for the sake of convenience and clarity, a detailed description thereof is omitted. Suffice it to say that the pitch change mechanism serves to vary the blade angle (β) of fan blades **36** which are suitably rotatably supported in hub **38** in any well known manner. In this embodiment because of the high blade solidity factor and the response characteristics, it is contemplated that the blades are reversed through feather, although such a requirement is not germane to this invention. If, however, that is the case, it would be desirable to provide a high pitch stop, short of feather, to prevent an inadvertent feather. Such a stop would be, in concept, similar to the low pitch stop customarily provided in all propellers that are powered by gas turbine engines, as for example, the 54H60 propeller manufactured by the Hamilton Standard Division of United Aircraft Corporation.

Referring to FIG. **1** it will be appreciated that the control **10** receives signals from a pair of control levers **40** and **42,** one being the condition lever which is utilized for starting, feathering, and shutting-off and the power lever, respectively. The conditioning lever and

its functions are well known and since it is not deemed a part of this invention, a detailed description is omitted for the sake of convenience and simplicity.

The power lever (PLA) serves to provide the input to the control so that the control **10** will automatically set the power of the gas generator to provide the necessary aircraft operating conditions in both forward flight and reverse modes. The control **26** is designed to provide rapid thrust modulation in the takeoff and landing modes and optimum TSFC in all cruise and long duration flight conditions.

Reference will next be made to FIG. **2** which schematically describes the control logic contemplated for effectuating the above. Ignoring for the moment the reversing interlocks **44, 46** and **48,** it will be noted that the power lever schedules free turbine speed (N_F ref) by generating a biased signal responding to flight Mach No. (M_N) and compressor inlet temperature (T_2) in the function generator **50.** Inlet temperature of the engine may be either low pressure compressor inlet temperature, high pressure compressor inlet temperature or fan inlet temperature. The actual fan speed (N_F) is compared with N_F ref in summer **52** which signal is passed to the governing compensation network **54.** Network **54** is a suitable well known proportional plus integral fan speed governor serving to modulate the fuel within the conventional fuel constraints scheduled by control **26.**

It is apparent from the foregoing that N_F is set as a function of PLA, T_2 and M_N and speed governing through the proportional plus integral fan speed governor modulates fuel flow to maintain the speed eror at zero.

In order to compensate for the inertia of the gas generator turbine and compressor and obtain fast thrust response by pitch change, it is desirable to incorporate an anticipatory circuit. This anticipatory signal responding to PLA rapidly changes fuel flow relative to the slow changes in N_F so as to provide the change in power needed to hold the desired speed of the fan while fan pitch is changed. This anticipatory signal which may be a suitable derivative signal, i.e., a reset which is proportional to the velocity of the input signal, minimizes fan speed excursions and helps to improve the thrust response characteristics during transient conditions.

While a well known

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type of mechanism may be employed as the anticipatory signal, FIG. **3** describes a preferred embodiment for effectuating the anticipatory function. In this instance the basic proportional and integral speed control is obtained by time integration of a derivative and proportional signal of speed error. Similarly power lever anticipation signal is obtained by time integration of a derivative signal.

In either instance, anticipation is a function of PLA and flight M_N, so that below a predetermined PLA and above a predetermined M_N no anticipation will occur. This is represented by the curve in box **64.** Thus at the point of the curve in function generator **56** where the curve becomes horizontal, the scheduled output is constant and hence no anticipation signal will ensue. It is only when the PLA reaches a predetermined value that